Convectively Driven mean-flows in Partially Enclosed Seas.

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LONG-TERM GOALS:

To understand, through laboratory experimentation, the dynamical processes that are responsible for the density and velocity structure of partially enclosed seas, i.e., those with a restricted connection to a larger, effectively infinite, reservoir.

SCIENTIFIC OBJECTIVES.

As a prototype for these systems we intend to model all possible aspects of the dynamics of the Red Sea. We wish to compare laboratory measurements with those taken during field surveys of the physical properties of the sea.

APPROACH.

Suitably instrumented laboratory models have been and will be constructed of an idealised Red Sea geometry. These models do and will include the effects of evapouration and wind-stress at the sea surface, and an exit geometry that mimics the prototype. A series of experiments have been and will be undertaken to fully explore the characteristics of these models. Comparison will be made with field observations.

WORK COMPLETED.

A relatively small, idealised, laboratory model of the sea was constructed before ONR support was forthcoming. This model incorporated a source of buoyancy at its top surface and suitably modelled exit conditions. Results are discussed below. As a consequence of these preliminary experiments it has become clear that a new apparatus needs to be built that is both larger and can incorporate effects (e.g., a wind stress) that are missing from the present model. This task is presently underway.

RESULTS.

A large number of experiments have been run over the past two years or so on the small (2m long) apparatus, using a variety of exit conditions. Density and velocity measurements have been made that show that the frictional model developed by us appears to be correct. In the cases where the exit has both a sill and a contraction the scaling laws for both the model and the prototype appear to agree to within experimental error. Thus both Red Sea and laboratory data can be represented by:

$$g'=(1.1\pm0.1)(B^{2/3})X/(H^{4/3}),$$

where g' is the buoyancy difference from the surface to depth, B is the buoyancy flux, X is the distance from the closed end of the sea and H the depth of the exit sill. Velocity measurements confirm that the exit flow is internally critical. Comparisons with the field data of Fritz Schott show that this critical condition can be used to estimate the velocity and volume flux from the sea itself, and to correct the commonly used values of the surface buoyancy flux. Thus, it is suggested that the correct value should be 3.8×10^{-4} (cm^2 s^{-3}).

IMPACT/APPLICATIONS.

Even with only the present results in hand we are able to make a number of suggestions for future field programmes. When the results from the new apparatus are at hand this abiliity will be increased considerably.

TRANSITIONS.

At the moment no transitions exist. It is hoped that in the future a stronger intercation with the field programmes will be possible, so that each group can gain from the experience and expertise of the other.

RELATED PROJECTS.

None at this time.

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